

M435 Studies in pure mathematics: metric and topological spaces and geometric topology

Level: 3 Credit points: 30
No computer required

Summary

Metric and topological spaces is a consideration of point set topology. Continuity is the motivating concept, leading to the discussion of compactness, connectedness and completeness in the abstract context of topological spaces. *Geometric topology* investigates surfaces such as the sphere, the torus, the Möbius band and the Klein bottle, and shows how to classify them combinatorially. Applications include the study of quadratic equations in two complex variables and Riemann surfaces.

Description

The course will give you an insight into two aspects of topology, an active and central branch of pure mathematics. By the end of it you should feel confident to tackle a wide range of problems and appreciate how versatile and applicable the methods of topology might be. The course consists of two independent sections that are studied concurrently. Each has its own course texts and written work based on a set book.

Metric and topological spaces

Set book: Sutherland *Introduction to Metric and Topological Spaces* (details in *Set book to buy* below).

This section considers point set topology from the standpoint of real analysis. It presents the language of metric and topological spaces with continuity as the motivating concept, and moves from the familiar conditions of real analysis to discuss compactness, connectedness and completeness in the more abstract context of topological spaces.

Geometric topology

Set book: Blackett *Elementary Topology: a Combinatorial and Algebraic Approach*, provided as part of the course material.

This section investigates various surfaces, such as the sphere, the torus, the Möbius band, the projective plane, the Klein bottle and so on, and shows how combinatorial techniques can be used to classify them. It continues by showing how this material can be applied to the study of quadratic equations in two complex variables, and introduces the concept of Riemann surfaces. We end with a brief look at flows with singularities: sources, sinks, vortices, crosspoints, etc. The initial approach to this material is intuitive and geometric; the text is supported by eight programmes on video cassette.

Entry

You are expected to be familiar with the concept of continuity, to the level of the Open University course M203 *Introduction to pure mathematics* (or any introduction to pure mathematics), and many of the concepts require considerable mathematical sophistication. If you have passed M203 with a grade 3 or better, you should be reasonably placed to study M435 successfully. It is a Level 3 course, which makes intellectual demands appropriate to the final year of an honours degree. If you have any doubt about your ability to take the course please seek advice from your Regional Centre.

Preparatory work

You could do some preliminary reading from the set book (Sutherland, Chapter 1), though the course texts provide much explanatory material to supplement even the earliest chapters of the book.

If you are disabled

M435 Metric and Topological Spaces and Geometric Topology

This course may present substantial difficulties if you have impaired sight, but it is not impossible. If you are a new student, make sure that you have our booklet *Meeting Your Needs*.

What's included

Course books, audio cassettes, video cassettes.

You will need

Audio and video cassette players

Set book to buy (2000 price)

W. A. Sutherland *Introduction to Metric and Topological Spaces* 1996 edition, Oxford University Press, ISBN 19853161 3, £17.50

Tuition and counselling

You will have a tutor who will help you with the course material and mark and comment on your written work, and whom you can ask for advice and guidance. We may also be able to offer group tutorials or day-schools that you are encouraged, but not obliged, to attend. Where your tutorials are held will depend on the distribution of students taking the course. Ask your Regional Centre if you need to know more before you decide whether to register. Your Regional Centre will provide a counselling service to give you general help with your studies.

Assessment

There are four tutor-marked assignments and an examination. Assessment is an essential part of the teaching, so you are expected to complete it all. But if you unavoidably miss or do badly in an assignment some courses allow you a 'substitution score', calculated as a weighted average of all your scores for the course. In M435 this rule can apply to one assignment. You will be given more detailed information when you begin the course.

Qualifications

This is a specified course in our MMath degree, and in our honours BSc in Mathematical Sciences and Computing, and in Mathematical Sciences. It can also count towards most of our other degrees at bachelor's level - it is equally appropriate to a BA or a BSc - and towards our discontinued Advanced Diploma in Mathematics Education. It is up to you to ensure that you are properly informed about the circumstances in which the course can count towards these qualifications.

Excluded combinations

Because the subject-matter of M435 overlaps with the discontinued course M386, and with several others in the same area that have not been available since 1989, you can count only one of these courses towards each Open University qualification. Please ask if you think you might be affected by this.

Professional recognition

This course may help you to gain recognition from a professional body. Ask your Regional Centre for *Recognition* leaflet 3.6.

For the future

This course is presented every four years, and 2001 may be its last year.

M386 METRIC AND TOPOLOGICAL SPACES AND GEOMETRIC TOPOLOGY

1991

				TELEVISION		AUDIO-CASSETTES		ASSIGNMENT	
study week	start date	course text	other components/notes	title	1355 Sat ²	title		number	cut-off date
				The television programmes apply only to geometric topology.*		There are no radio programmes associated with this course.			
1	Feb 9	GT1		1 Topological surfaces	Feb 9	AC218 GT1			
2	Feb 16								
3	Feb 23	MTS1							
4	Mar 2								
5	Mar 9	GT2		2 Orientability	Mar 9	AC218 GT2			
6	Mar 16								
7	Mar 23	MTS2				AC216 MTS2		TMA 01	Mar 27
EASTER									
8	Apr 6								
9	Apr 13	GT3		3 The projective plane $\mathbb{R}P^2$	Apr 13	AC218 GT3			
10	Apr 20								
11	Apr 27	MTS3				AC215 MTS3			
12	May 4								
13	May 11	GT4		4 Classifying surfaces geometrically	May 11	AC218 GT4			
14	May 18								
15	May 25	MTS4				AC215; AC216; AC217 MTS4		TMA 02	May 29
16	June 1								

17	June 8	GT5	5 Complex loci	June 8	AC219; AC220 GT5		
18	June 15						
19	June 22	MTS5					
20	June 29						
21	July 6	GT6	6 Covering surfaces	July 6	AC219; AC220 GT6		
22	July 13						
23	July 20	MTS6			AC217 MTS6		
24	July 27					TMA 03	July 31
25	Aug 3	GT7	7 Winding numbers	Aug 3	AC219 GT7		
26	Aug 10						
27	Aug 17	MTS7			AC217 MTS7		
28	Aug 24						
29	Aug 31	GT8	8 Flows	Aug 31	AC219 GT8		
30	Sept 7						
31	Sept 14	MTS8					
32	Sept 21					TMA 04	Sept 25
33	Sept 28						

Assessment strategy: Two assessment components: (i) TMAs 01–04 (50%); and (ii) the final examination (50%). Substitution as described in your Student Handbook will apply for up to one TMA.

Footnotes ²=BBC 2 MTS=Metric and Topological Spaces; GT=Geometric Topology ³You must leave time to study the TV pre-work BEFORE you watch the programme. After viewing the programme, listen to the cassette summary. Please note that there are also Faculty and general University programmes which will be of interest to you. Please see overleaf for details.



BROADCAST AND ASSIGNMENT CALENDAR 1991

A detailed 1991 timetable for your course is given overleaf. The notes below are intended to help you to make the best use of your calendar.

Course text and start date

You are advised to begin your study of the course units or blocks as numbered in the week shown in this column.

Other components/notes

This column may note the home experiments; projects; etc., where applicable, in the week in which you are advised to begin them. You may also find it useful to jot down other commitments, such as tutorials, day schools, summer schools, etc., or your study plans and plans for additional work such as extra reading.

Programme numbering

Sometimes programmes are broadcast in a different order from the order in which they were planned. Where the course team has chosen to give them a sequential number different from the original BBC number, the BBC number will be given in brackets after the title. It is important to quote this number in any inquiry you may wish to make about a programme.

Audio and video cassettes

Some courses use cassettes instead of, or as well as, broadcast programmes. This is indicated on the calendar.

the *Student Handbook 1990* in both Section 7 and Appendix 4.

TRANSMISSION TIMES

Regular transmission times

The regular transmission days and times are given at the top of the television and radio columns. Unless otherwise stated in the column next to the relevant programme, all programmes are broadcast at these times.

Programmes transmitted after midnight will be expressed as 2425 and the date used will be that of the preceding day, that is, it will be expressed as a continuation of the preceding day's transmissions.

Delays in transmission affecting late night television

The University's broadcasts at midnight and 2425 are dependent upon the time of BBC2 General Service closedown. The closedown time varies from day to day in response to BBC2 schedules, world events, sports programmes, etc. It is therefore likely that some of the University's programmes will be delayed from time to time. Such delays are unlikely to be for longer than ten minutes, but see note below.

In both of the cases above you are strongly advised to check the transmission details of your programmes in Radio Times or daily papers, as sometimes they may be changed from those printed on the calendar. If you are still unsure, ring the **Central Enquiry Service** (number below).

Breakdown in transmission

Weekday programmes, or parts of programmes, (over three minutes) which are lost because of a national breakdown will be re-broadcast at 0710 or 0735 on Thursday and/or Friday mornings not more than 10 days later. Breakdowns at the weekends are more likely to affect large numbers of programmes, which may not fit into the Thurs-

specific courses but which you may find interesting and useful.

Open Forum Magazine: a series of programmes, containing news and views on topical issues and developments in the Open University, provisionally scheduled for broadcasting on BBC2 at 1110 on the following Sundays:

10 Feb (rpt 0945 Sat 16 Feb)
10 Mar (rpt 1100 Sat 23 Mar)
14 Apr (rpt 1035 Sat 27 Apr)
12 May (rpt 1100 Sat 25 May)
9 June (rpt 0830 Sat 15 June)
7 July (rpt 1100 Sat 20 July)
4 Aug (rpt 1035 Sat 10 Aug)
1 Sep (rpt 1100 Sat 7 Sep)

Open Advice: a series of programmes aimed at new students giving information and advice on various key aspects of Open University study, including summer schools, exams, the use of libraries, and advice for applicants, provisionally scheduled for broadcasting on BBC2 as follows:

Where do Open University students come from?

Sat 5 Jan 0950
Sun 28 Apr 1110

There's a degree in me somewhere

Sat 12 Jan 0950
Sun 24 Feb 1110

The Open University is for you

Sat 19 Jan 0950

Using the Library

Sat 26 Jan 0950
Sun 24 Mar 1110

So you want to be a better manager?

Sun 26 May 1110
Sun 18 Aug 1110

Looking forward to summer school

Sun 23 June 1110
Sun 21 July 1110

Preparing for the exams

Sun 15 Sept 1110
Sun 29 Sept 1110

Where the title of a programme has not been decided at the time of going to press, the letters 'T.B.A.' will indicate that the title is to be announced at a later stage. Alternatively provisional titles or topics will appear in brackets; these may alter before the programmes are transmitted but the subject matter will remain the same. Similarly, programme titles printed in *Radio Times* may be different from those on your calendar but this does not necessarily mean that the programme has changed.

Channels

Television programmes are transmitted on BBC1 or BBC2 (UHF, 625 lines only) and BBC Cymru/Wales (625 lines only). The channel for each programme is indicated by a footnote (either '1' or '2') against the broadcast time on the calendar. It is important to ensure that you are tuned to the correct channel for **your** programme, as different Open University programmes may be broadcast simultaneously on different channels. Radio programmes are broadcast on either Radio 3 FM or Radio 5 MW, indicated by the footnotes '3' or '5' on the calendar.

Variations in radio broadcasts in Northern Ireland, Scotland and Wales

Radio 3 FM broadcasts cover the whole of the UK but the Radio 5 MW service has poor reception in some National Regions. The service may be replaced in Wales by Radio Cymru, in Scotland by Radio Scotland VHF and in Northern Ireland by Radio Ulster VHF. See your local *Radio Times* for details.

Assignments

In the assignment column the assignment cut-off dates (the last date by which an assignment should be submitted) are shown. At the foot of the calendar the assessment strategy for the course is given. Detailed information about the submission of assignments and assessment strategy is given in

any new transmission time in a stop press, if there is time, or by BBC announcement (see below).

Changes to transmission times

In the event of a change you will, wherever possible, be notified in a Stop Press from the course team, by letter from the University or by special announcement on Open Forum on the Radio or Ceefax (see also note on special announcements). **If you are in any doubt, you are advised to contact the Central Enquiry Service at Walton Hall,** telephone: 0908 653231 (out of office hours answering service).

Special announcements

"Newsflash" announcements may be necessary for last-minute changes to broadcast details for assignment cut-off dates, etc. It may also be necessary to inform students of postal delays concerning course and administrative mailings. Announcements may be transmitted on radio Open Forum and broadcast changes are also carried on Ceefax on page 286 (Educational Special Announcements). Once again, if you are in any doubt, you are advised to contact the **Central Enquiry Service** on the above numbers.

Off-air recording

You may wish to record your programmes for your own use. This is quite permissible. **It is not, however, permissible for you to record a programme causing it to be heard by others, recorded or sold.** This infringes Section 14 of the Copyright Act 1956. Educational institutions wishing to record Open University programmes should apply for an off-air recording licence to: Guild Sound and Vision Ltd., 6 Royce Road, Peterborough, PE1 5YB.

Programmes of general interest

The Open University broadcasts throughout the year a number of radio and television programmes which are not directly related to

topical weekly broadcasts on Radio 5 every Sunday at 1203 from 3 February to 29 September (except for 31 March)

Open Advice on the Radio: a series broadcast on Radio 5 as follows:

The First Hurdle

Sun 17 Feb 1222

Sun 17 Mar 1341

Sun 21 Apr 1920

Summer School and beyond

Sun 19 May 1222

Sun 16 June 1341

Sun 14 July 1241

Completing the course

Sun 8 Sept 1220

Sun 29 Sept 1940

Please note that some of these programmes may be subject to change and that you should check in *Sesame* or the *Radio Times* for more up to date information.

FACULTY PROGRAMMES

There are two series of radio programmes broadcast on Radio 5 throughout the year which will be of interest to students studying in particular subject areas:

Maths, Science and Technology – every Sunday at 2000

Arts, Education and Social Science – every Sunday at 2020

BROADCAST AND ASSIGNMENT CALENDAR 1991

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STUDY CALENDAR

M435 METRIC AND TOPOLOGICAL SPACES AND GEOMETRIC TOPOLOGY

1994

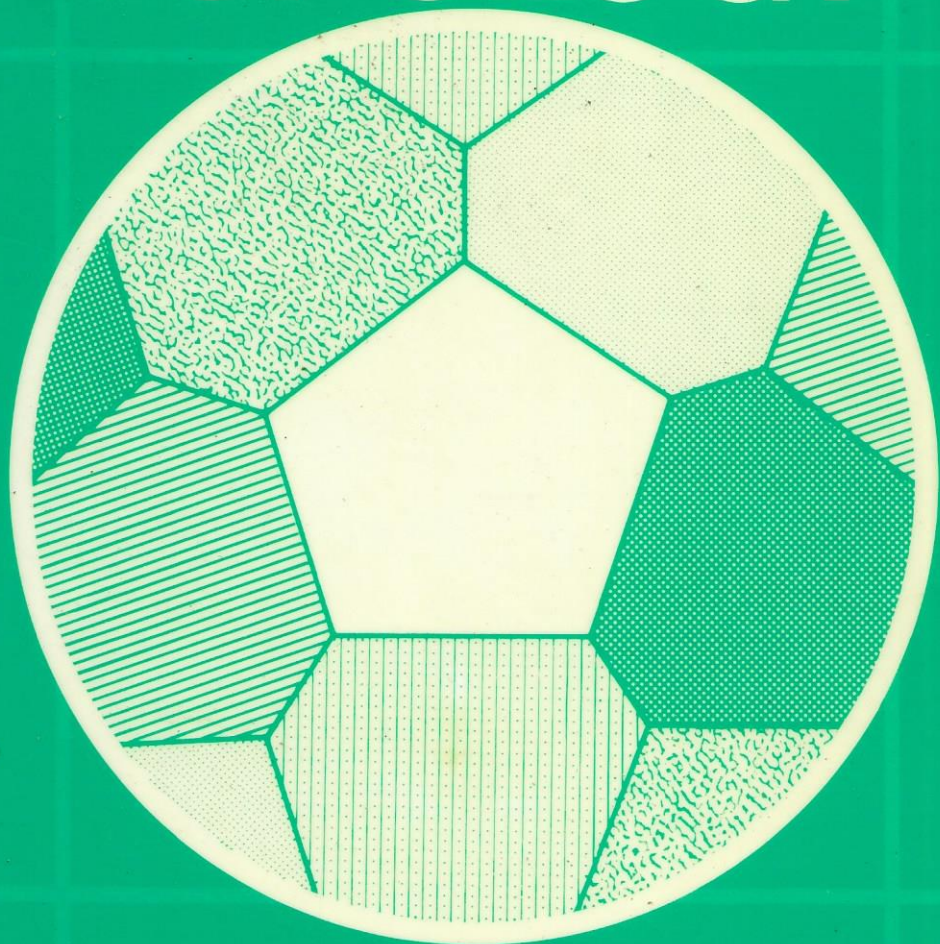
				VIDEO-CASSETTE	AUDIO-CASSETTES	ASSIGNMENT	
study week	start date	course text	other components/notes	title	title	number	cut-off date
				There are no television or radio programmes associated with this course. Students will be sent video and audio cassettes which should be listened to as indicated.			
1	Feb 12	GT1	Video Cassette 1	1 Topological surfaces	AC218 GT1		
2	Feb 19						
3	Feb 26	MTS1					
4	Mar 5						
5	Mar 12	GT2		2 Orientability	AC218 GT2		
6	Mar 19						
7	Mar 26	MTS2			AC216 MTS2	TMA 01	Mar 31
	EASTER						
8	Apr 9						
9	Apr 16	GT3		3 The projective plane RP^2	AC218 GT3		
10	Apr 23						
11	Apr 30	MTS3			AC215 MTS3		
12	May 7						
13	May 14	GT4		4 Classifying surfaces geometrically	AC218 GT4		
14	May 21						
15	May 28	MTS4			AC215; AC216; AC217 MTS4	TMA 02	June 2
16	June 4						

17	June 11	GT5	Video Cassette 2	5 Complex loci	AC219; AC220 GT5	
18	June 18					
19	June 25	MTS5				
20	July 2					
21	July 9	GT6		6 Covering surfaces	AC219; AC220 GT6	
22	July 16					
23	July 23	MTS6			AC217 MTS6	
24	July 30					TMA 03 Aug 4
25	Aug 6	GT7		7 Winding numbers	AC219 GT7	
26	Aug 13					
27	Aug 20	MTS7			AC217 MTS7	
28	Aug 27					
29	Sept 3	GT8		8 Flows	AC219 GT8	
30	Sept 10					
31	Sept 17	MTS8				
32	Sept 24					TMA 04 Sept 29
33	Oct 1					

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ELEMENTARY TOPOLOGY



A COMBINATORIAL
AND ALGEBRAIC APPROACH

DONALD W. BLACKETT

This book has been written as a text for a course in topology for undergraduates. It assumes a basic knowledge of calculus. The book treats selected topics from one, two, and three dimensions, primarily by combinatorial and algebraic methods.

After a chapter of examples, combinatorial methods are used to classify surfaces and to study covering surfaces. The concept of winding number is used to examine mappings into the sphere and vector fields on the plane and sphere. The fundamental theorem of algebra and the two-dimensional cases of the Brouwer fixed point theorem and the Borsuk-Ulam theorem are all covered. The homology of networks is developed and applied to the Kirchhoff-Maxwell laws and to a transportation problem. The final chapter provides a brief introduction to three-dimensional manifolds.

The concepts developed in each chapter are illustrated both by drawings and diagrams and by worked examples in the text. At the end of each chapter there is a set of exercises designed to reinforce students' understanding of the material covered and to develop certain topics further.

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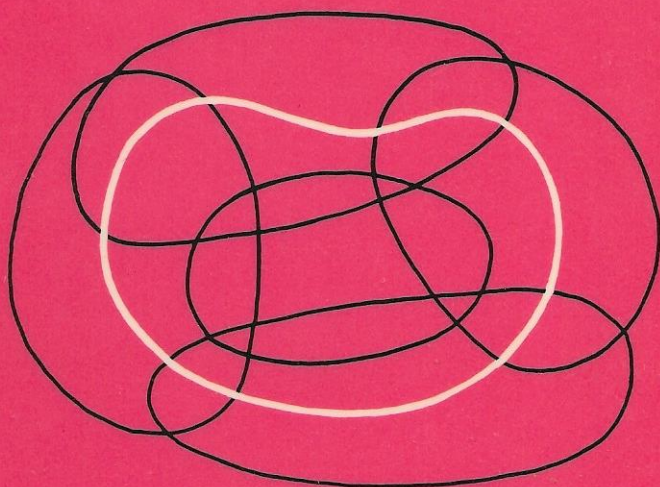
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Tokyo 102, Japan

W. A. SUTHERLAND

Introduction to Metric and Topological Spaces



OXFORD SCIENCE PUBLICATIONS

One of the ways in which topology has influenced other branches of mathematics in the past few decades is by putting the study of continuity and convergence into a general setting. This book introduces metric and topological spaces by describing some of that influence. The aim is to move gradually from familiar real analysis to abstract topological spaces. After establishing the language of metric and topological spaces with continuity as the motivating concept, the discussion develops to cover compactness, connectedness, and completeness. The book is aimed primarily at the second-year mathematics student, and numerous exercises are included.

The author is a Fellow of New College and Lecturer in Mathematics in the University of Oxford. He has previously taught at the Massachusetts Institute of Technology and at Manchester University.

OTHER TEXTBOOKS PUBLISHED BY OXFORD UNIVERSITY PRESS

Probability: an introduction

Geoffrey Grimmett and Dominic Welsh (1986)

Introduction to complex analysis

H. A. Priestley (1985)

ISBN 0-19-853161-3



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